CONSERVATION STRATEGIES FOR RARE AND THREATENED VERTEBRATES OF AUSTRALIA'S WET TROPICS REGION

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In September 1992, 50 specialists gathered to evaluate the conservation status and management needs of vertebrates of the Wet Tropics Region. Participants agreed that 12 vertebrate species (3 mammals, 2 birds, 6 frogs and 1 fish) warranted urgent restorative action, while others required a 'watching brief', and sensitive and coordinated management of their habitats. Of highest priority were the critically endangered regional endemic mammals *Petaurus gracilis* and *Bettongia tropica*, and six species of frogs, *Taudactylus acutirostris, T. rheophilus, Litoria nannotis, L. nyakalensis, L. rheocola* and *Nyctimystes dayi*. □ *Rare species, threatened species, Wet Tropics Region, vertebrates, conservation status, management, rainforests, Queensland.*

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The Wet Tropics Region is an area of high biodiversity. It supports over 500 species of rare and/or threatened plants and animals (Switzer, 1991), and has more rainforest-dependent endemic vertebrates than any other area in Australia. Most of these are confined to cool, wet forests above 400 m. A significant proportion of the region has been accorded World Heritage status in recognition of its biological values. Accordingly, there is now an international obligation, to maintain biodiversity. This involves targeting taxa which, by virtue of their restricted distributions, scarcity and/or susceptibility to threatening processes, may be vulnerable to extinction. It also involves the identification of recurring and/or common threatening processes and threatened habitats or places. The process of fine-tuning various conservation efforts which have been initiated at the national or state level in the Wet Tropics context required the input of essential local knowledge. In order to design an effective meld of conservation strategies, the World-Wide Fund for Nature (Australia) instigated a process of consultation, and secured necessary funding from the Wet Tropics Management Authority, to bring together experts on the region's flora and fauna. Fifty specialists met in Cairns, 2-4 September, 1992, to discuss approaches to rare and threatened species conservation (Werren, 1992). The workshop's purpose was to identify taxa, populations, assemblages and habitats requiring special conservation attention, and means to optimise efforts to ensure their survival.

The Wet Tropics biogeographic province of Australia (Stanton & Morgan, 1977) is located in the northeastern coastal region of Queensland, between Cooktown and Townsville and is roughly bounded landward by the 1000mm p.a. rainfall isohyet (Werren et al., in press). The province covers over 16000km^2. It contains the most extensive continuous tracts of rainforest in Australia. Regional species diversity is enriched by the occurrence of non-rainforest vegetation, including sclerophyllous open forest and grassy woodland, sclerophyllous swamp forest and sedgelands, mountain heathlands, saline coastal herbfields and mangrove forests.

REGIONAL CONSERVATION STATUS

The workshop attendees compiled current information on the conservation status of each vertebrate taxon. For many taxa, it must be recognised that knowledge is inadequate. Reference to these taxa is consistent with the scientific nomenclature recognised by the Queensland Museum (Ingram & Raven, 1991), except for bats. For this group names used by G.Richards & L. Hall, pers. comm., have been followed. Common names follow Strahan, 1983 for mammals; Royal Australasian Ornithologists Union, 1978 for birds; Ingram et al., 1993 for frogs; Wager, 1993 for fish. For reptiles, common names are few, but follow Cogger (1992).

While the basic taxonomic unit considered was the species, attention was also given to subspecies and/or population isolates. This was to optimise

the chances of maintaining maximum genetic diversity and to avoid overlooking undescribed species or subspecies, and populations of organisms which are genotypically or behaviourly (if not phenotypically) distinct. It allowed identification of threatening processes and threatened sites from direct field knowledge of the regional biota.

Establishing the conservation status of the region's vertebrate fauna required the assignment of generally understood codes for each taxon (e.g. Thomas & McDonald, 1987). Conservation management application necessitated determining priorities for action. The lack of precise quantitative data generally precludes the use of complex systems such as those developed by Millsap et al. (1990) and Macc & Lande (1991). It meant that this part of the exercise was intuitive, rather than quantitatively reliable. However, it was systematic and in keeping with the principles applied by Goosem & Young (1989).

A number of subgroups were convened to focus on particular vertebrate groups. Each subgroup systematically considered each taxon and addressed the question - 'does this organism require any special conservation management attention above and beyond the cautious general ongoing requirements for the maintenance of biodiversity in this region - and, if so, what is it?'. In focussing on single species or groups of taxa (guilds), it was considered important that those remaining should also receive management and research attention.

As a result of these considerations, several general management categories were devised: priority 1 - critically endangered taxa urgently requiring the immediate removal of threatening processes and the rapid implementation of recovery plans; priority 2 - endangered taxa requiring rapid implementation of recovery plans; priority 3 - vulnerable taxa requiring intensive study and possible interventionist management; priority 4 - taxa of special conservation concern requiring close monitoring and possible interventionist management.

Threatened taxa belonging to the first, along with the various status assessments previously ascribed, are listed in Table 1. Local knowledge sometimes prompted determinations different from those devised at the national/international level (e.g. omission of 8 of 12 critically endangered species from the CONCOM list - Hicks, 1991), and to a lesser extent, at the state level (e.g. elevation of the Southern Cassowary, *Casuarius casuarius johnstonii* from 'V' of Ingram & Raven, 1991, to 'E'; and inclusion of the Golden Bowerbird, *Prionodura newtoniana* as a vulnerable species in the regional assessment).

CONSERVATION ASSESSMENT

Mammals

Of the 90+ species recorded from the Wet Tropics Region, 11 species of mammal (1 antechinus, 4 ringtail possums, 1 glider, 1 rat-kangaroo, 2 tree-kangaroos, 1 bettong, 1 mosaic-tailed rat), are restricted to this area. The known Australian distributions of two other species (Long-tailed Pygmy-possum, *Cercartetus caudatus*; Flute-nosed Bat, *Murina florium*) are the Wet Tropics and New Guinea, and the Wet Tropics and Southeast Asia respectively. There are nine endemic subspecies of mammals, many of which have populations to the south. This indicates that the Wet Tropics has the highest mammalian endemism of any region in Australia (Winter, 1991). Three species appear on the 'CONCOM List of Endangered Vertebrate Fauna' (Hicks, 1991), and 20 are listed by Van Dyck (1991) as being of special conservation concern.

Most of the endemic mammals are non-volant upland rainforest species. Most have either restricted ranges or isolated populations (e.g. Atherton Antechinus, *Antechinus godmani*; Lemuroid Ringtail Possum, *Hemibelideus lemuroides*; Daintree River Ringtail, *Pseudocheirus cinereus*; Herbert River Ringtail, *P. herbertensis*, Green Ringtail Possum, *Pseudocheirops archeri*; and Thornton Peak Mosaic-tailed Rat, *Melomys hadrourus*). This attaches to them conservation management problems associated with fragmentation and small populations (Kennedy, 1992). Others (Bennett's Tree-kangaroo, *Dendrolagus bennettianus*; Lumholtz's Tree-kangaroo, *D. lumholtzi*; Musky Rat-kangaroo, *Hypsiprymnodon moschatus*) occur at all altitudes. Another Wet Tropics endemic species, the Mahogany Glider (*Petaurus gracilis*), has been rediscovered only recently, and is restricted to limited tracts of lowland open forest/woodland between Ingham and Tully (Van Dyck, 1993).

For the volant mammals, the Wet Tropics, along with Cape York Peninsula, is an area of high species diversity (Richards, 1990a; 1991). At least 35 species of bats, about half of Australia's total, occur in the region (Rainforest Conservation Society of Queensland, 1986). This group comprises species which play pivotal roles in ecosystem processes such as plant pollination and dispersal, particularly in rainforest systems.

TABLE 1. Wet Tropics rare and threatened vertebrate species warranting highest priority conservation management

	Taxon	CONCOM status (April 1991)	Ingram & Raven (1991)	Workshop determination (September, 1992)
MAMMALS	*Petaurus gracilis*, Mahogany Glider	not listed	2E	critically endangered
	Murina florium, Flute-nosed Bat	not listed	3RC+	threatening processes not established
	Bettongia tropica, Tropical Bettong	endangered	2EC	endangered, threatening processes possibly increasing
BIRDS	*Casuarius casuarius johnstonii*, Southern Cassowary	vulnerable	3VC+	Australian endemic subspecies considered endangered
	Prionodura newtoniana, Golden Bowerbird	not listed	–	appears to be in decline
FROGS	*Taudactylus acutirostris*, Sharp-snouted Dayfrog	endangered	3EC	massive & rapid range contraction; critically endangered
	T. rheophilus, Northern Tinkerfrog	not listed	3EC	not recorded for 2 years; critically endangered
	Litoria nannotis, Waterfall Frog	not listed	–	declining; critically endangered
	L. nyakalensis, Mountain Mistfrog	not listed	–	no recent records; critically endangered
	L. rheocola, Common Mistfrog	not listed	–	declining; critically endangered
	Nyctimystes dayi, Australian Lace-lid	not listed	–	declining; critically endangered
FISH	*Melanotaenia eachamensis*, Lake Eacham Rainbowfish	endangered	not assessed	extinct in the wild; captive population

Many are restricted to particular foraging areas (e.g. aquatic foraging over still pools by the Large-footed Mouse-eared Bat, *Myotis adversus*) or to specialised foods (e.g. spider gleaning by the Golden-tipped Bat, *Kerivoula papuensis*; the pale rainforest fruit preferences of the Spectacled Flying-fox, *Pteropus conspicillatus*, Richards, 1990b). Others have morphological characters which indicate habitat specialisation (e.g. wing-folding to shed water and water repellent pelage of *M. florium*, allowing foliage roosting in cloudy upland rainforests, Richards, 1983). Others require particular roosting and reproductive sites (e.g. stenothermic/stenohydric roost sites of the Eastern Horseshoe-bat, *Rhinolophus megaphyllus* or Horseshoe-bats, *Hipposideros* spp., and preference for sea caves by the mangrove-foraging North-eastern Sheathtail-bat, *Taphozous australis*). Such specialisation is reflected in the fact that about 60% of the total Australian bat fauna is considered to be rare/uncommon, and that 16 of the 35 species recorded for the Wet Tropics are ascribed special conservation status (3 endangered, with *M. florium* listed as critically endangered; 2 vulnerable; 4 rare; and 7 insufficiently known, Richards & Hall, pers. comm).

Five groups of mammal species with different management needs were defined: 1. critically endangered (*P. gracilis, M. florium, B. tropica*, Table 1.): 2. endangered, but presumed not critically so (Ghost Bat, *Macroderma gigas* and *K. papuensis*); 3. vulnerable restricted endemics (*D. bennettianus, D. lumholtzi*), and sparse or declining taxa (northern subspecies of the Spotted-tailed Quoll, *Dasyurus maculatus gracilis*; northern subspecies of the Red-cheeked Dunnart, *Sminthopsis virginiae virginiae*; north-eastern subspecies of the Yellow-bellied Glider, *Petaurus australis reginae*; Greater Wart-nosed Bat, *Hipposideros semoni*; *P. conspicillatus*; Water Mouse, *Xeromys myoides*[1]); 4. remaining Wet Tropics endemic taxa (*A. godmani, P. herbertensis, P. cinereus, P. archeri, H. lemuroides, H. moschiatus, M. hadrourus*, Common Dunnart, *S. murina tatei*, Coppery Brushtail Possum, *Trichosurus vulpecula johnstonii*; Swamp Rat, *Rattus lutreolus laccus*) and other taxa which are restricted Wet Tropics population isolates, poorly known and/or suspected to be declining (White-footed Dunnart, *S. leucopus*; Squirrel Glider, *Petaurus norfolcensis*; *C. caudatus*; Feathertail Glider, *Acrobates pygmaeus*; Bare-backed Fruit-bat, *Dobsonia moluccense*; Large-eared Horseshoe-bat, *Rhinolophus philippinensis*;

[1]Not recorded in the Wet Tropics, but found to the south and northwest. As extensive habitat suitable for *X. mygoides* occurrs in the area, it was considered useful to include this species in discussions (S. Van Dyck, pers. comm.)

Rhinolophus sp. *maros* form; *T. australis*; Diadem Horseshoe-bat, *H. diadema*; Little Bentwing Bat, *Miniopterus australis*; *M. adversus*; Naked-rumped Sheathtail Bat, *Saccolaimus saccolaimus*; Greater Broad-nosed Bat, *Scoteanax rueppellii*; Little Brown Cave-bat, *Vespadelus pumilus*; north-east Queensland subspecies of the Black-footed Tree Rat, *Mesembriomys gouldii rattoides*; Prehensile-tailed Rat, *Pogonomys mollipilosus*); and, 5. widespread species occurring in restricted or vulnerable habitats in the Wet Tropics (Platypus, *Ornithorhynchus anatinus*; Koala, *Phascolarctos cinereus adustus*; north-eastern subspecies of the Swamp Wallaby, *Wallabia bicolor mastersii*; Water Rat, *Hydromys chrysogaster*). Other taxa were flagged for attention in special conservation efforts and inventory programs. The latter will be concentrated in special habitats (e.g. lowland sclerophyll open forest/woodland, tall open forest, freshwater wetlands, mangroves and remnant lowland rainforest and riparian communities).

Changes in habitat floristics and structure, fragmentation, increased incursion by 'edge' species, barriers to animal movement, and competition or predation by alien species impact on mammals of the Wet Tropics. *P. gracilis* is endangered due to clearing of lowland sclerophyll open forest-/woodland in the southeast of the region (Van Dyck, 1993). Lowland habitat loss may also threaten species such as *S. v. virginiae* and the Long-tailed Planigale, *Planigale ingrami*.

B. tropica has suffered habitat loss and modification through grazing and changes to long-standing fire regimes, increased predation from dogs, and may suffer increased predation from the European Red Fox (*Vulpes vulpes*). There are historic records of this exotic canid (e.g. 1962 at McKenzie's Pocket, Black Mountain corridor - K. Sanderson, pers. comm.). These may indicate its lengthy presence in the region. However, they appear to be isolated records of possible escapees or vagrants. Stanton (pers. comm.) has a long familiarity with the region and reports seeing a fox first in 1990, a roadkill at Home Hill, NEQ. Then, in 1991, M.Davis (pers. comm.) recorded a live animal at Mt Carbine, and more recently, (1993) M. Trenerry and M. Prociv (pers. comm.) noted two road-killed foxes (and collected hair samples) in 2km of the Kennedy Hwy, near Kuranda. The former is near the two northerly population isolates of *B. tropica*, while the latter is in the vicinity of Lamb Ra. population. The regional presence of *P. australis reginae* is threatened by loss, fragmentation and modification of its tall open forest habitat on the western fringe of the rainforested uplands.

The continued loss and degradation of mangrove habitat is of concern. This is predicted to impact on populations of taxa such as the Common Brushtail (*T. vulpecula*) and Common Ringtail (*Pseudocheirus peregrinus*) Possums, as well as *X. myoides*, which has a CONCOM rating of 'vulnerable' (Hicks, 1991). Additional fragmentation and disruption of lowland rainforest and associated communities is destructive for species such as the *H. moschatus*, particularly by opening areas up to marauding domestic and feral dogs.

The loss and disruption of roosting and maternity sites through cave or mine collapse, quarrying operations and tourist visitation is significant to a sizeable proportion of the region's bat fauna. Species so affected include *M. gigas*. Endangering processes affect this species extra-regionally. In the Wet Tropics *M. gigas* occurs in the Black Trevethan Ra. area and appears secure. Also affected are *H. semoni, H. diadema* and *R. philippinensis*. A colony of the latter near Mt Molloy has been severely reduced over the last decade (Richards & Hall, pers. comm).

Direct human predation, colony disruption, tick infestations and loss of lowland and upland rainforest have increased pressure on *P. conspicillatus* (Richards, 1990b). Destruction of *Pteropus* specimens or habitat stems from concern associated with loss of fruit from orchards and gardens. With the expansion of fruit-growing activities and settlement about Cooktown, the regionally rare *D. moluccense* may be subjected to similar pressures (Richards & Hall, pers. comm).

Birds

Of the 360+ bird species recorded for the Wet Tropics, 13 are endemic to this province. Nine of these are restricted to the more temperate uplands (Crome & Nix, 1991). Ten other bird species have subspecies confined to the area and a further eight rainforest species have a major part of their ranges within this area. There are 10 subspecies endemic to the Wet Tropics. Nine of the 13 endemic species are confined to the upland rainforests (Crome & Nix, 1991). All the endemic birds have close relatives in Papua-New Guinea, but many of the endemic subspecies are representative of species which are Australian endemics with essentially southeastern Australian ranges. The region also is the stronghold of a number of species - e.g. Red-necked Crake (*Rallina tricolor*), Papuan Frogmouth (*Podargus papuensis*), White-

rumped Swiftlet (*Collocalia spodiopygia*) and Metallic Starling (*Aplonis metallica*).

Discussions revealed the importance of two 'priority 1' taxa warranting rapid recovery action plans. These are the Southern Cassowary (*C. casuarius johnsonii*), which has the bulk of its distribution in the Wet Tropics and Golden Bowerbird (*P. newtoniana*), which is endemic to the region. The former already receives attention, particularly in the Mission Beach area. Survey, monitoring and a comprehensive community-driven campaign designed to raise the bird's conservation requirements in the regional planning context, to inform the public of the bird's plight and to encourage protective action are underway (Werren & Goosem, in press). *P. newtonia* is of special concern due to its natural sparseness in parts of its range. Its bowers have 'disappeared' from The Crater and Butcher's Ck areas of the Atherton Tableland in the past 2-3 years, and it has been the target of ecotourism activities. These may be disrupting its leks and reducing its reproductive success.

There are a number of other species whose ranges extend into the Wet Tropics which are regarded as endangered, rare and threatened or declining. These are predominantly raptors and finches and include the endangered Gouldian Finch (*Erythrura gouldiae*[2]) and eastern subspecies of the Star Finch (*Neochmia ruficauda ruficauda*), the vulnerable Red Goshawk (*Erythrotriorchis radiatus*), the rare and declining Square-tailed Kite (*Lophoictinia isura*) and the white-rumped subspecies of the Black-throated Finch (*Poephila cincta cincta*), as well as the Plumed Frogmouth (*Podargus plumiferus*). Conservation of these species is a national rather than regional issue. Efforts expended on them in this region must contribute within this wider context. Accordingly, it is difficult to assign any of these highly mobile animals to the general management categories applied to other groups. The Beach Thick-knee (*Burhinus neglectus*) is also regarded as vulnerable (a more appropriate category may well be 'endangered'). This species is so sparsely distributed along beaches in the Wet Tropics and extralimitally, that it is difficult to envisage how efforts might be focussed to determine its status and environmental requirements to effect recovery.

A common theme to the discussions concerning the conservation of the Wet Tropics avifauna emanated from the view that certain guilds of birds play key functional roles in ecosystems. *C. casuarius johnstonii*, is a 'keystone' species (Crome & Moore, 1988) as a dispersal vector of many large-fruited rainforest plants. Frugivorous pigeons, the Barred Cuckoo-Shrike (*Coracina lineata*), *A. metallica*, Figbird (*Sphecotheres viridis*) the Orioles (*Oriolus flavicinctus, O. sagittatus*) and honeyeaters are important as plant dispersers or pollinators.

Loss of habitat, particularly in the lowland systems and coastal wetlands, remains an ongoing threat to the regional conservation status of some bird species. The Wet Tropics bird specialist group identified various taxa which are restricted to, or have their strongholds in restricted localities or in habitats which are rare and/or where threats from development and ongoing landuse practices are severe. These are birds of the coastal lowlands and foothills, mangroves, freshwater wetlands and riparian forest. Loss of habitat integrity due to disturbance or through foraging activities of domestic pets and feral animals such as pigs, presents a problem for the survival of the regional avifauna.

Fire is associated with decline of some bird species in other tropical regions (Woinarski, 1990). Late dry season fires can cause a reduction in breeding sites for species such as hollow-breeders, may increase vulnerability to predation of ground-breeders and have affected the survival prospects of *E. radiatus* chicks (Aumann & Baker-Gabb, in Garnett, 1992a). Changes in fire regimes which allow proliferation of fire weeds, or reduce variety in a habitat mosaic, can also disadvantage *C. casuarius johnstonii* (Stanton, in Garnett 1992a).

Avian diseases also appear to be implicated in declines of some taxa. *Tuberculosis* infections have been reported increasingly in the Southern Cassowary (L. Moore, pers. comm.), raising concern about the spread of disease to stock. Avian pathologies are probably connected with declines observed in finch population (Tidemann et al., in press).

Displacement of native species by introduced birds such as Indian Mynahs (*Acridotheres tristis*), House Sparrows (*Passer domesticus*) and the Spice Finch (*Lonchura punctulata*) is also threat to some taxa. While the former two species are essentially restricted to intensively settled areas, the latter is widespread.

Illegal bird collecting appears to be a greater problem on Cape York Peninsula and in semi-arid

[2] Not normally regarded as part of the avifauna of the Wet Tropics, although old records of this species from the area exist.

habitats than in the Wet Tropics. However, vigilance is required to protect such sought-after birds such as the Fig Parrot (*Cyclopsitta diophthalma macleayana*), the vulnerable *P. cincta* and the rare Blue-faced Parrot Finch (*Erythrura trichroa sigillifer*).

Reptiles

Over thirty rainforest-dependent reptile species occur in disjunct rainforests of the Wet Tropics (Covacevich, in press). Also restricted to the Wet Tropics are *Nactus galgajuga*, *Carlia scirtetis*, *Ctenotus terrareginae*, *Delma mitella* and *Cacophis churchilli*.

Many Wet Tropics reptiles have very narrow geographic ranges. This makes them vulnerable if significant portions of their restricted ranges are disrupted. Such species are regarded as 'R' taxa (species which are rare in Australia, but not currently considered endangered or vulnerable). They may be represented by a relatively large population in a restricted area or by smaller populations spread over a wider range, or some intermediate combination of distribution patterns (Ingram & Raven, 1991). Most occur in conservation reserves. None is known to be threatened. For other species, however, including some whose ranges are peripheral to the region, more information on their conservation status is required. Ten species (*D. mitella, Anomalopus gowi, Ctenotus eutaenius, C. hypatia, C. monticola, C. nullum, C. quinkan, C. terrareginae, Lerista zonulata, Lygisaurus tanneri* and *Simoselaps warro*) are rated as 'K' (McDonald et al., 1991), indicating they are 'poorly known species...'.

While there is the need for more systematic distribution and autecological information for at least 11 species of reptile which occur in or near the Wet Tropics, there was consensus that there is no immediate need for interventionist management of reptiles of the Wet Tropics.

No known widespread threats to the regional reptile fauna were identified. Global warming may prompt a reappraisal of this determination with respect to the summit zone endemic species. Feral pigs were considered likely to threaten local populations through direct predation and through habitat disturbance. The Queensland Department of Environment and Heritage's policy to remove Estuarine Crocodile (*Crocodylus porosus*) specimens from some sites was considered to be affecting the species' regional survival. *C. porosus* also has a high international conservation ranking (Perran Ross, 1992). Illegal collecting and road traffic may also be threatening local populations of some snake species.

Frogs

Of the 210 Australian frog species (Tyler, 1992), 53 occur in the Wet Tropics Region. Twenty-two of these occur nowhere else. The greatest number of rainforest-obligate/dependent endemic frog species (at least 20 of the 22 described species, including three myobatrachids, six hylids, and at least 11 microhylids) occur in the region (McDonald, 1992; Covacevich & McDonald, 1993). Several species are also yet to be described.

Given the world-wide phenomenon of frog 'disappearances' (Heyer, et al., 1988; Weygoldt, 1989; Blaustein & Wake, 1990; Tyler, 1992), the loss of frog species of the genera *Taudactylus* and *Rheobatrachus* in south and mideastern Queensland, and other species in the southeast of the continent (Richards et al., 1993), there is grave concern for the survival of species in the Wet Tropics. The narrowly restricted microhylids are not the focus of this concern. Populations of lotic stream-dwellers from the rainforest uplands are declining dramatically.

There are at least six species (*Taudactylus acutirostris, T. rheophilus, Litoria nannotis, L. nyakalensis, L. rheocola, Nyctimystes dayi* - Table 1) which have undergone recent population crashes (Richards, et al., 1993). A seventh species, the Armoured Mistfrog (*L. lorica*), is poorly known, but is suspected, due to its lotic breeding habit in upland rainforest streams, to belong to this declining group.

Outcomes of the discussions of the Wet Tropics herpetofaunal specialist group included the identification of four groups of species warranting special consideration. The group of six endemic upland lotic frog species mentioned above was considered to require immediate, 'priority 1' attention. The urgency of recovery action and research with respect to these species was accepted as a major workshop recommendation (Werren, 1992).

Another group (*L. lorica*; the Whirring Treefrog, *L. revelata*; the Windsor Nursery-frog, *Cophixalus bombiens*; Tapping Nursery-frog, *C. concinnus*; Bloomfield Nursery-frog, *C. exiguus*; Pipping Nursery-frog, *C. hosmeri*; Southern Nursery-frog, *C. mcdonaldi*; Tangerine Nursery-frog, *C. neglectus*; and Boulder Nursery-frog, *C. saxatilis*) was regarded of secondary consideration ('priority 3' taxa). These are narrow Wet Tropics endemics (apart from *L. revelata*, which

has a disjunct distribution and is narrowly restricted in this region) from land which currently has a secure conservation tenure.

All remaining endemics (Covacevich & McDonald, 1993) were regarded as a third group requiring monitoring to ensure their continued survival.

A fourth group, which included species with extralimital distributions (the Northern Sedgefrog, *L. bicolor*; Green Treefrog, *L. caerulea*; Eastern Sedgefrog, *L. fallax*; Graceful Treefrog, *L. gracilenta*; White-lipped Treefrog, *L. infrafrenata*, which are often collected for the pet trade), was also of conservation concern. This group, together with the remaining endemics, fall into the 'priority 4' category.

Factors responsible for the 'disappearances' of some taxa, and the range contraction and declines in abundance of others are far from understood. What is known has been reviewed by Richards et al. (1993). Tyler (1992) comments that 'there is indeed a number of disappearances that at present cannot be explained'. He cites the cases of population crashes experienced by the Northern Platypusfrog (*Rheobatrachus vitellinus*) and Eungella Dayfrog (*T. eungellensis)* in mideastern Queensland that 'simply defy any reasonable explanation'.

Collecting colourful tree frog species is responsible for the local decline of some taxa and is of concern elsewhere (Tyler, 1992). This problem is being addressed with the present Schedules of Listed Fauna and in the Nature Conservation Act (Queensland) 1992, where frogs are now included as 'native fauna' and have the same protection as other vertebrates, except fish.

Freshwater Fish

The significance of the Wet Tropics Region to Australia's freshwater fish fauna is highlighted by the fact that 69 of the 188 Australian species (37% of the total fauna) occur in the region's streams (R. Wager, 1993). This represents the greatest regional diversity in Australia (Trenerry & Werren, 1991). A significant portion of this fauna has attracted special conservation interest (Wager, 1993).

Any treatment of the region's freshwater fish is greatly constrained by poor taxonomic and distributional knowledge. There is a relatively small endemic component, with three described and a further two undescribed species noted for the area (Trenerry & Werren, 1991; Wager, 1993). These include the Roman-nosed Goby, *Awaous crassilabrus*; Mulgrave Goby, *Glossogobius* sp.; *Scortum* sp.; Cairns Rainbowfish, *Cairnsichthys rhombosomoides*; and Lake Eacham Rainbowfish, *Melanotaenia eachamensis*. The last is presumed to have occurred only in Lake Eacham, a small crater lake on the Atherton Tableland. Introduction of predatory fish led to its extinction in the wild (Barlow, et al., 1987; Trenerry & Werren, 1991). In addition, there is one vulnerable species (Macculloch's Rainbowfish, *M. macculloch*i). None is rare, but 27 species are poorly known and suspected to belong to one of the other conservation status categories. The poorly known component amounts to 44% of the regional fauna or 90% of species which are ascribed special conservation status. The view was expressed that many of these may be threatened taxa. Just over one half of the region's fish fauna is regarded as secure (Wager, 1993).

In any assessment of the status and conservation requirements of the region's fish, two points must be stressed. 1. Fish populations are highly variable, both spatially and temporally, and assessment of population status must recognise this; and, 2. occurrence in a protected area cannot guarantee survival.

M. eachamensis requires high priority remedial attention, and, given that its continued existence is dependent on the maintenance of vulnerable captive populations, it is ascribed the status of 'endangered' (Wager, 1993, erected the category of 'presumed extinct in the wild' to accommodate this taxon). Questions about its taxonomic status, are under investigation (C. Moritz, pers.comm).

*M. macculloch*i, has declined in some of its Wet Tropics range. Although adjudged to be common/secure by Wager (1993), this species was considered 'vulnerable' within the region, deserving attention as a 'priority 3' taxon.

Of the 27 species requiring more information before their conservation status can be precisely determined, particular priority should be assigned to those which, on the basis of current information, are endemics or are recorded from restricted localities within the region. These constitute 'priority 4' taxa.

A complex suite of known threatening processes to freshwater fish was identified. Most are associated with catchment modification (e.g. removal/alteration of riparian vegetation, increases in sedimentation and pollution runoff associated with catchment clearing and landuse) and stream flow regime regulation (e.g. increases in water abstraction associated with the growing regional resident and visitor population, hydroelectricity generation, barriers to along-stream

fish movement). A further threat to the native freshwater fish assemblages and to survival ability of some species is the introduction of exotics. A variety of ornamental species kept by aquarists has become naturalised in streams of the region. These include a significant number of live-bearers such as the Guppy (*Poecilia reticulatus*), Swordtail (*Xiphophorus helleri*), the Platy (*X. maculatus*) and a species used for insect pest control, the Mosquito Fish (*Gambusia holbrooki*), mouth-breeders such as two Tilapias (*Tilapia mariae, Oreochromis mossambicus*). These fish modify competition and predation dynamics, usually to the detriment of native species. Other threats include translocation of non-local native species, direct exploitation of some species for recreational fishing and, to a lesser extent, aquarium trade, proliferation of ponded pasture species such as *Brachiaria mutica* which chokes channels and disrupts flows, invasion and destruction of riparian vegetation by exotic weeds such as *Thunbergia grandiflora* which changes water temperatures, and the disturbance of stream stretches due to feral pig activities.

CONSERVATION STRATEGIES

Conservation of species is totally reliant on the conservation of their habitats. The maintenance of maximum variety in the landscape is the essential objective of any exercise aimed at the conservation of species. Particular assemblages or ecosystem types can be lost unless there is an attempt to remove threatening processes. Also, with conservation of tracts of habitat, species conservation can be additive and compounding (e.g. with the assignment of protective tenure on stands of lowland sclerophyll forest/woodland between Cardwell and Tully, the survival chances of the critically endangered *P. gracilis* may be significantly advantaged. In addition, the survival chances of other species of small mammals and birds, possibly some restricted fish taxa as well as a host of rare and threatened terrestrial and epiphytic orchids, other higher plants, a myriad of invertebrates and lower plants, will be significantly enhanced).

Despite the diverse professional interests of participants, there was unanimity of purpose, concern and approach to the task of conserving the Wet Tropics biota. There was recognition of the need for integrated and biologically explicit management planning, based soundly on detailed local knowledge. A conceptual framework through which this integrated and informed management can be achieved has been expounded by Hopkins & Saunders (1987). They argue for the adoption of an organisational structure which accepts that management must proceed concurrently with the gathering of data for the purpose of improving management decisions. The process is ongoing and must be incorporated into management systems. This provides for an enhancement of management capability of a nature conservation agency through the clear articulation of directions and the means through which objectives will be achieved. However, much uncertainty remains in the realm of non-conservation agency activity within the region.

The actions of essential service agencies, local government agencies and the entire gamut of private landholders, non-government institutions and structures, impact on the regional biota. They are thus responsible for endangering processes.

There was agreement to press for (i) the adoption of the primacy of protecting rare and/or threatened species as the cardinal principal guiding regional planning; (ii) the need for government agencies operating in the region to produce medium-term (five year) plans for their operations; (iii) an insistence on thorough scrutiny of infrastructure provisioning and development proposals which impinge on rare and/or threatened species during EIS/EIA review; (iv) the need to enact provisions of robust state conservation legislation to protect rare and threatened species when the situation arises; and (v) the forging of clear agreements with private landholders for the protection of rare and/or threatened species and their habitats.

Various taxa, systems and localities have been identified as worthy of immediate high priority interventionist management attention through implementation of recovery plans. Target taxa are detailed in Table 1. The systems of the lowlands, including poorly protected open sclerophyll communities, remnant rainforest, riparian communities, freshwater wetlands and mangroves warrant special conservation attention. In addition, tall open forest communities on the western fringe of the rainforested uplands and summit zones were viewed as deserving of same. Various localities also were considered vital for the conservation of rare and/or threatened species and systems. With respect to vertebrate conservation, the most significant of these was part of the Tully-Ingham lowlands, the habitat of *P. gracilis* (Van Dyck, 1993).

Other species and systems of concern were specified. For these the best protection was afforded by threat abatement mechanisms in the context of careful regional planning and development proposal review, together with the fostering of integrated catchment management.

It was also considered imperative that day-to-day conservation management enshrinc the protection of rare and/or threatened species and systems as a central tenet. Negotiation with landholders to enhance conservation efforts on lands beyond the conservation reserves and the promotion of active public participation in conservation efforts and monitoring programs was deemed essential also.

The ultimate conservation management objective is to diminish the numbers of threatened systems and taxa through threat abatement, and to address the particular conservation requirements of target taxa which have become imperilled due to human activity. It is appropriate at the regional level to focus on the total number of taxa when setting such conservation management objectives (Hopkins & Saunders, 1987).

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SIZE AND DIET OF *BUFO MARINUS* IN RAINFOREST OF NORTHEASTERN QUEENSLAND. *Memoirs of the Queensland Museum 34(1):240. 1993:-* The widespread occurrence of the exotic *Bufo marinus* in open habitats and its feeding strategies there are well documented (e.g. Freeland, 1984). Not studied so well are patterns of occurrence and diet of *B.marinus* in rainforest.

Between Dec., 1985 and Jan., 1986, at two predominantly rainforested sites, we collected, measured and examined gut contents of 257 specimens of *B.marinus*. Site 1,'Carbine Uplands' is a traverse of 22.4km through notophyll vine forest along the Mt Lewis Forestry Rd. Site 2, 'Daintree Lowlands' is the 52.4km road from Noah Ck to Bloomfield (incorporating the years old section from Cape Tribulation to Bloomfield). This runs mainly through mesophyll vine forest, but includes cleared and open-forested tracts. At site 1, 102 specimens were obtained; at site 2, 155. Size-class distribution and gut contents (Table 1) of *B. marinus* collected from the two sites during 235 person-hours (between 2000 and 0350hrs) are compared.

A comparison of frequency distributions of snout-urostyle length reveal differences between samples from the two sites. The Carbine Uplands sample was essentially normally distributed around a mean adult length <10cm, suggesting an established population which is in equilibrium with its resource base, along the lower section of traverse to an upper altitudinal limit of ca 900m. That from site 2 clearly exhibited a positive skew around a mean length >10cm and indicates greater numbers of large adult toads (usually females - the largest measuring 19.8cm). Because the second site comprised a 52.4km traverse, of which 32.4km was the new Cape Tribulation-Bloomfield section, this difference can be interpreted as evidence of an invading or pioneering population, where larger sizes are attained due to exploitation of resources that had not been utilised formerly by toads. This is consistent with the work of Freeland (1984) in the Gulf of Carpentaria lowlands. It also supports the view that the newly constructed road acted as a route of 'infection', for toads (with other exotics) into rainforest.

Analysis of stomach contents confirms previous work (eg, Mungomery, 1936; van Beurden, 1980; Strussmann et al., 1984; Freeland et al., 1986), showing consumption of a wide range of invertebrates, but a clear preference for ants and beetles. Notable also is the ingestion of arachnids (both spiders and scorpions), and scolopendromorph centipedes, indicating resilience of *B. marinus* to their venoms. A Chi^2 test (at $p_{crit.}$ = 0.001), shows significant differences between diets of toads at the two sites (more oligochactes, diplopods, collembolans and curculionids in the upland rainforest vs more slugs, orthopterans and homopterans in the lowlands). Both populations appear to be foraging similarly, largely as predators of arthropods and other invertebrates. In so doing, *B. marinus* is a competitor of native anurans and other small vertebrates. Only one instance of vertebrate prey (a road-killed *B.marinus* being cannibalised) was recorded during the survey. This was one of only three such instances in surveys over 4 summers, between 1985-1989. The others were specimens of *Ramphotyphlops* sp., and *Rana daemeli*, a juvenile.

TABLE 1.Diet of *Bufo marinus* from two rainforest sites, NEQ.

Prey Item	Percentage of stomachs containing prey items			
	Site 1	Site 2	Total	Sig. Diff. p>0.001
Earthworms	12.7	3.9	7.4	yes
Snails	11.8	5.8	8.2	—
Slugs	0.9	11.6	7.4	yes
Scorpions	1.9	4.5	3.4	—
Spiders	12.7	17.4	15.6	—
Harvestmen	11.8	10.9	11.3	—
Slaters	4.9	3.9	4.3	—
Millipedes	36.3	21.3	27.3	yes
Centipedes	11.8	12.3	12.1	—
Springtails	11.8	1.9	5.8	yes
Cockroaches	10.8	22.6	17.9	—
Crickets/Katydids	22.5	36.1	30.7	yes
Earwigs	4.9	8.4	7.0	—
Termites	6.8	4.5	5.4	—
Bugs	3.9	7.1	5.8	—
Leafhoppers/Cicadas	0.9	6.5	4.2	yes
Butterfly/Moth larvae	9.8	11.6	10.9	—
Beetles (excl. weevils)	86.2	67.7	75.1	—
Weevils	52.9	30.9	39.7	yes
Ants (other)	79.4	73.5	75.9	—
Bull Ants	26.5	—	10.5	—
Green Tree Ants	—	22.5	13.6	—
Vertebrates	—	0.6*	0.4	—
Mineral	56.9	26.5	38.5	yes
Plant	60.8	67.7	65.0	yes
(Nematode parasitism)	7.8	12.9	10.9	—
Number	102	155	257	—

* single record, road-killed *B. marinus*

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